Docket Number: 920976.90199

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Barbara R. Evans *et al.*

Serial No.: 10/017,202

Filed: December 14, 2001

Title: "Metallization of Bacterial Cellulose for Electrical and Electronic Device Manufacture"

Art Unit: 1745

Examiner: Raymond Alejandro

DECLARATION UNDER 37 C.F.R. § 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

1. I am the first named inventor for the above-identified patent application.

2. I read the comments in the Office Action of August 12, 2004 regarding the need for Applicants to provide evidence that the claimed invention is necessarily different from the combined prior art product. In order to address this need for evidence, I comment as follows.

3. Bacterial cellulose has special properties that make it suited for formation, stabilization, and utilization of nano- and micro-sized metal particles. The cellulose possesses aldehyde groups that function as reducing compounds to initiate nucleation of the metal particles from aqueous solution (see attached Figure 1). The hydroxyl groups of the cellulose then act to coordinate and limit the growth of the metal particles, so that highly crystalline particles of sizes 2-20 nm are formed, instead of the large,

micrometer-sized agglomerates that are formed by incubation of dilute aqueous metal salts such as ammonium hexachloropalladate with glucose and other reducing sugars, that is, sugars with aldehyde groups. The bacterial cellulose is able to carry out this reaction much more effectively than plant cellulose such as cotton linters because bacterial cellulose is hydrophilic and naturally sponge-like, thus its reducing ends and hydroxyl groups are surface accessible to the aqueous metal salts (see attached Figures 2 and 3).

4. The type of fuel cell assembly described and claimed in the present application is unique in that it exploits the formation of new hydrogen bonds between adjacent cellulose fibers during the drying process to seal together the layers of cellulose. The cellulose is maintained in a highly crystalline fibrous state, with the x-y dimensions maintained while the y-dimension is greatly compressed (1 cm to 50 micrometers for each cellulose layer). The bonding between the layers is stable to hydration, i.e., presence of water. In this regard, the assembly process is completely different from modified cellulose such as methyl, carboxymethyl, and hydroxyethyl cellulose, which compounds function as water-soluble pastes.

5. The use of dilute aqueous solutions (5-10 mM, that is, % w/v) and temperatures between ambient and 90°C for nucleation and growth of the metallic particles in the method described in the present application is a chemical deposition method using the oxidation-reduction potentials of the metal salt and the cellulose reducing ends (see attached Figure 4). Conventional vapor deposition processes as in the cited patents uses high temperatures to vaporize metallic metals and deposit them on surfaces in a vacuum chamber.

6. The relatively slow growth of the metal particles using the method described in the present invention results in high crystallinity of the particles, as has been demonstrated by Transmission Electron Microscopy (TEM) images taken at the Metals and Ceramics Division of Oak Ridge National Laboratory (see attached Fig. 5).

7. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the above-identified application or any patent issuing thereon.

Dated: December 6, 2004

Barbara R. Evans

Barbara R. Evans

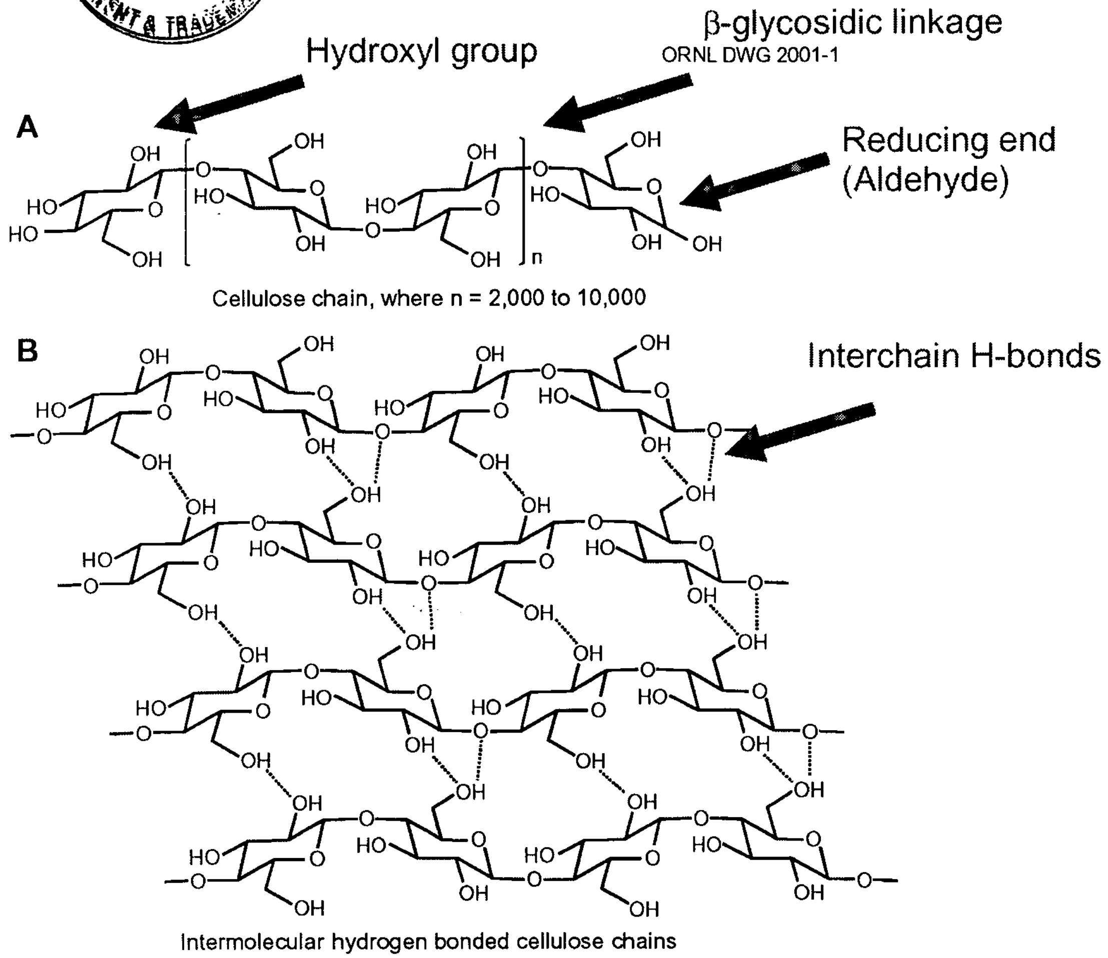

Figure 1. The chemical structure of cellulose contains groups important to the chemical reduction and nucleation of metal particles, namely aldehyde and hydroxyl groups. The extensive hydrogen bonds between the glucose chains of the cellulose impart to it its crystalline nature.

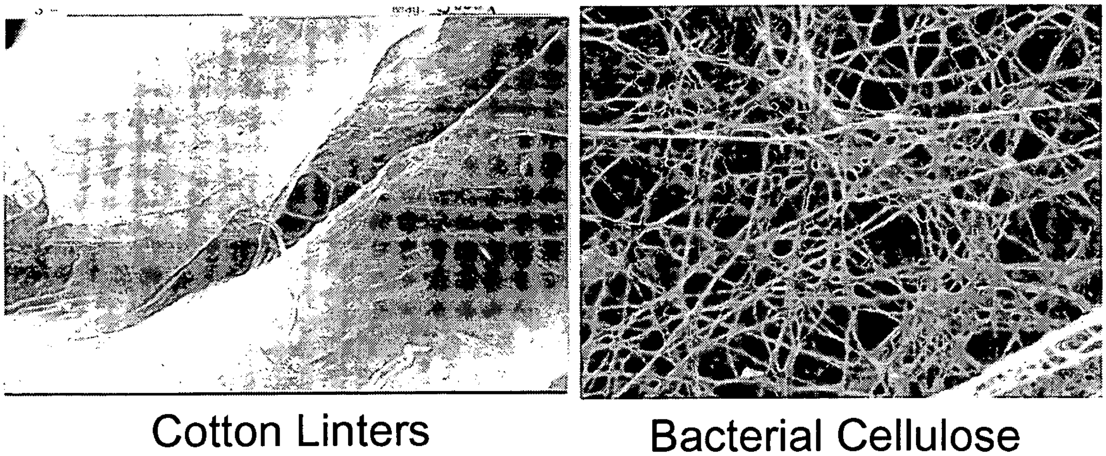

Figure 2. Scanning electron microscopy (SEM) at 5000X magnification of cotton cellulose (left) and bacterial cellulose (right). Imaging was carried out by Dr. Paul Menchofer of the Metals and Ceramics Division, Oak Ridge National Laboratory, at the User Center, High Temperature and Materials Laboratory, Oak Ridge National Laboratory.

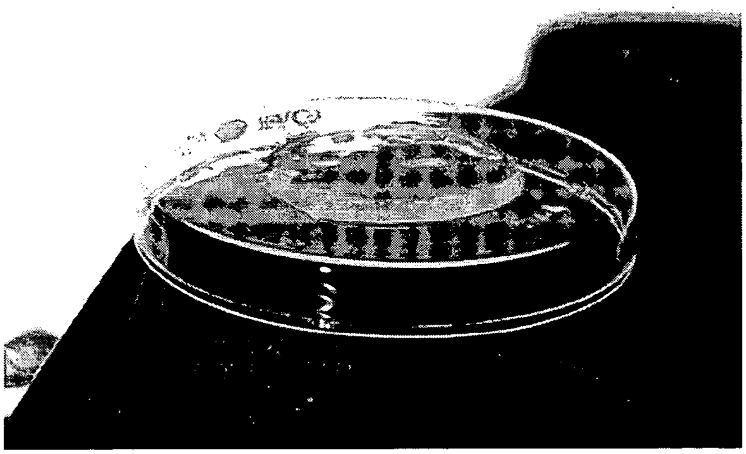

Figure 3. The sponge-like microstructure of bacterial cellulose imparts to it a hydrophilic character. Hydrated pellicules of bacterial cellulose contain one-hundred fold weight of water.

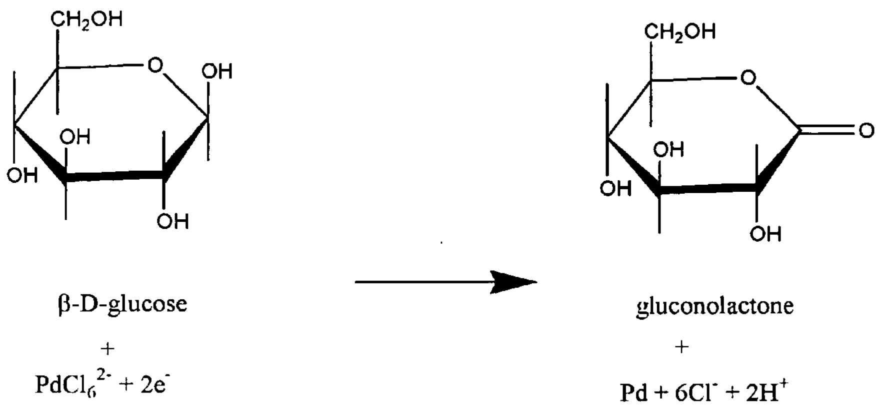

Figure 4. The chemical reduction of hexachloropalladate to palladium metal by the reducing end of the terminal glucose of a cellulose chainin aqueous solution initiates the deposition of the palladium particles in the bacterial cellulose matrix.

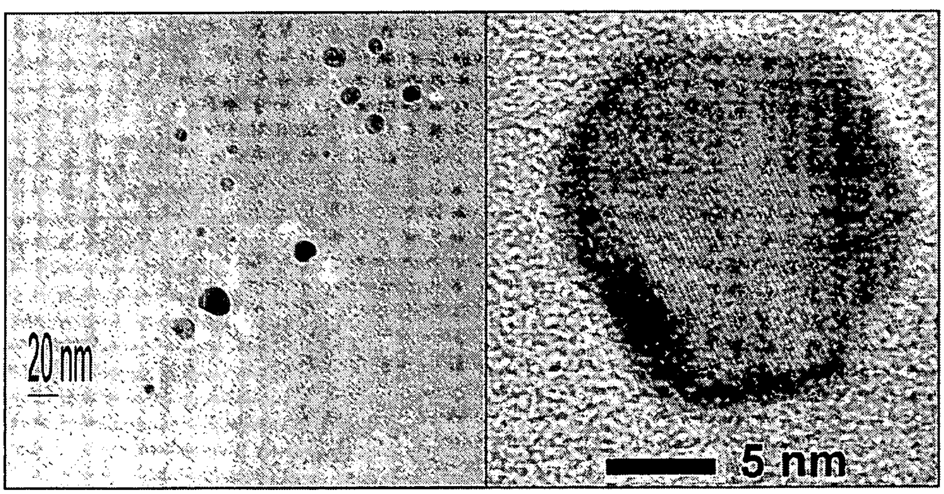

Figure 5. Size and crystallinity of the palladium particles formed in the bacterial cellulose matrix is revealed by transmission electron microscopy (TEM). Imaging was carried out by Dr. Jane Y. Howe, Metals and Ceramics Division, Oak Ridge National Laboratory.